Nature-based Solutions for Urban Biodiversity Governance

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Abstract

In this paper, we examine how cities are working with nature-based solutions for biodiversity. Drawing on a sample of 199 nature-based solutions across Europe, we identify how cities work with nature-based solutions to *conserve* nature, *restore* nature, and to find ways to *thrive* through harnessing nature's contribution to people. Our findings show that cities are making explicit contributions to biodiversity through nature-based solutions, and often adopt specific and quantifiable targets to guide their actions. Yet there is significant variation in the ways in which biodiversity goals and interventions are being pursued. Where biodiversity goals and actions are included in nature-based solutions, they are mainly ecosystem-based - focusing on the protection, restoration or enhancement of the integrity, functionality, and connectivity of habitats and ecosystems - with fewer focused on specific species, and very few projects concerned with genetic diversity. Although it is often assumed that urban action towards biodiversity goals will be undertaken through local planning processes, our analysis shows that European cities are taking project-based actions for biodiversity through a set of explicit, quantitative and measurable targets, which are tailored to the specific conditions of urban settings. On the basis of these findings, we suggest that if cities are to achieve ambitious goals for biodiversity over the next decade, new international frameworks being developed for the post-2020 period should include targets that acknowledge the way in which biodiversity is governed in cities and the contribution that cities make to conserve, restore and thrive with nature to guide urban action.

***Key words**: Nature-based solutions; biodiversity governance; cities; conservation; restoration*

1 Introduction

Since the Rio Earth summit of 1992 and the ratification of Convention of Biological Diversity (CBD) and Agenda 21, action to implement the global biodiversity goals has taken place through a series of scaled national, regional and local polices (UNEP, 1992). While Parties to the CBD were urged to develop national biodiversity strategies and action plans (NBSAPs) for achieving the objectives of the CBD (and the subsequent CBD Strategic Plan 2011-2020 & 20 Aichi Targets), local authorities were encouraged to produce local biodiversity strategy and action plans (LBSAP) to pursue biodiversity conservation and sustainable development at the local level (Harrison and Davis, 2002; Evans, 2004). In many national contexts, LBSAPs thus became the primary instrument used by cities for managing biodiversity, enabling local action and informing overarching city plans and decisions. Although cities with different levels of resources and social contexts adopt a variety of approaches to formulating their LBSAPs, the construction of an LBSAP often involves: stakeholder engagement using cross-sectoral partnership; establishing a baseline of localised social and ecological characteristics; identifying threats and opportunities for biodiversity conservation; and producing action plans to enhance resources with targets for achievement over a ten-year period identifying partners and lead actors undertaking them (Avlonities et al., 2012; Evans, 2004; Puppim de Oliveira et al., 2014).

Despite the good intentions behind the development of LBSAPs, they have faced several challenges in practice. One key issue seems to lie in the institutional capacity to govern biodiversity and conflicting views and interests among stakeholders (Wilkinson et al., 2013). Guided by a national framework that is often rather abstract and based on specialist knowledge, urban planners, who often lack resources or capacities and have limited access to appropriate knowledge, can struggle to translate these requirements into tailor-made actions. Instead, they have to resort to traditional planning techniques (e.g. zoning and mapping) and pre-existing knowledge and networks for developing the LBSAP (Elander et al., 2005; Evans, 2004). This not only serves to exclude many stakeholders in the decision-making process, but also to limit biodiversity action to the geographical areas within the jurisdictional boundaries and regulatory capacities of the planning system. These boundaries can be problematic in terms of the relation between local authority jurisdictions and meaningful scales for action, which may occur beyond these administrative boundaries or in a patchwork of the myriad of urban sites that lie outside the planning system (Elander et al., 2005;

Cumming, Cumming & Redman, 2006). At the same time, a focus on local biodiversity action planning has tended to restrict an understanding of the ways in which urban governance takes place to those modes of regulation and self-governing which are most closely associated with formal land-use planning and management (Bulkeley & Kern, 2006).

Further, critiques have shown that plan-based nature conservation is dominantly science-led such that the wider social and cultural values of urban conservation are often not formally recognized or integrated due to the lack of an accepted and legitimized criteria (Harrison and Davis, 2002; Mendiondo, 2008). This is problematic as Bomans et al. (2010) point out that spatial policies and plans that were based on coarse, mono-functional categories, were unable to take into account transformations in multiple land uses and related values tied to the rapidly changing urban landscape. Together, these issues suggest that by focusing on urban planning processes alone, the range of actions and capacities for governing biodiversity at the local level may be being (inadvertently) circumscribed. Plan-based urban biodiversity governance appears therefore to be insufficient in terms of meeting the changing global biodiversity agenda and its calls for a transformative approach which recognizes not only the importance of science-based targets, but also the wide and often contested values that different communities hold for nature (Díaz et al., 2019). Furthermore, as this global agenda for biodiversity expands to focus not only on questions of conservation but also of restoration and ensuring that nature's contributions to people are realised in such a way as to enable multiple benefits for society, the extent to which urban planning alone can secure transformative change is moot.

More recently, and often in parallel to plan-based urban biodiversity governance, new interventions for governing urban nature – captured by the umbrella term nature-based solutions (NBS) – have emerged (European Commission, 2016). NBS are defined by the International Union for Conservation of Nature (IUCN) as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (Cohen-Shacham et al., 2016, p. 4). They are deliberate interventions that can be inspired by or support nature in addressing urban challenges (Bulkeley et al. 2017) and are seen to hold significant promise in enabling the urban transition to sustainability and addressing several sustainable development challenges such as climate change, water management, land-use and urban development, social interaction promotion, and

biodiversity conservation (Raymond et al., 2017). NBS can operate in diverse urban settings, including external building greens (e.g. green roofs), parks and semi-natural areas, community gardens, bioswales for stormwater capture, green indoor area, green infrastructure and urban forests on derelict land (Bulkeley and Raven, 2017), which are all important arenas for the governance of urban biodiversity and ecosystem services (Wilkinson et al., 2013).

The multi-functional nature of NBS and their potential for addressing social, economic and ecological sustainability challenges simultaneously is increasingly recognized in research and policy communities as meaning that NBS hold promise as innovations that hold great potential to facilitate wider urban transformation (Cohen-Shacham et al., 2016; Nesshöver et al., 2017; van der Jagt et al., 2019). In addition, it is suggested that because of their multi-functionality they have the potential to provide co-benefits that bridge social, cultural, environmental, and economic interests, with the result that they can effectively engage multiple actors (Kabisch et al., 2017; Raymond et al., 2017). For example, NGOs can implement NBS in partnership with other state or non-state actors to facilitate local biodiversity or wider environmental actions (e.g. The Nature Conservancy's Water Fund program in Mexico city and in Cape Town), and private sectors that are often either excluded or only taking a consultant role of the policy-making and planning process, can lead NBS that contributes to biodiversity conservation and promote local economy through job creation (e.g. as is the case with a beekeeping project at the Audi factory in Hungary). NBS thus encompass diverse local actions for biodiversity and provide an inclusive and adaptable framework for urban biodiversity governance that can contribute to environmental, social, and economic benefits. As momentum grows behind recent calls for international biodiversity policies that emphasise the importance of recognizing and preserving nature's contribution to people as a key goal, nature-based solutions have come to be seen as a key means through which this can be achieved, for example in the 2019 IPBES Global Assessment report and the Zero Draft of the Post-2020 Global Biodiversity Framework published in January 2020 (Díaz, S. et al. 2019; CBD, 2020).

The recent emergence and uptake of nature-based solutions in urban development (especially in European cities) reflects a broader phenomenon now extensively documented in the literature on urban sustainability governance which suggests that experimentation has come to dominate the modus operandi of governing the city towards sustainability (Bulkeley,

Castan Broto, & Edwards, 2015). In the past two decades, a range of interventions and pilot projects in socio-technical innovations have been practiced with the aim to explore pathways for building transitions towards “smart-city”, “low-carbon city”, and urban sustainability more broadly (e.g. Raven et al., 2017; den Hartog et al., 2018). Such initiatives are now widespread across cities in both the global North and the global South. Furthermore, not only is experimentation shaping the landscape of urban efforts towards sustainability, it is now argued to be “a new mode of governance” in its own right (Karvonen, 2018:2). The project-based, experimental form of nature-based solutions and their position as a means through which the governing of sustainability can be accomplished is, we suggest, part of this move towards experimentation as a means through which urban governance takes place. While to date experimentation as a mode of governing sits alongside traditional models of strategic and land-use planning, evidence suggests that under conditions of fragmented authority and considerable uncertainty about future (climate) urban conditions it is gaining momentum (Bulkeley, 2019).

However, despite the rise in project-based, experimental governance for urban sustainability through nature-based solutions, our understanding of how and to what extent the current such approaches can contribute to the urban governance of biodiversity is still limited. Responding to this challenge, this paper analyses a sample of NBS projects that involved different urban settings (namely urban parks, rivers, and community gardens). Through a systematic analysis of the biodiversity goals and explicit actions of these NBS in *conserving* nature, *restoring* nature, and *thriving* with nature (where this is understood to be seeking to purposefully realize what the IPBES Global Assessment refer to as Nature’s Contributions to People and encompasses the benefits and values nature generates for individuals and society), we investigate the incorporation of biodiversity concerns in current urban NBS projects In European cities and explore how NBS are (and can be) contributing to urban biodiversity governance. In doing so, we seek to offer a new perspective on the cities’ role in realizing global biodiversity.

The remainder of the paper is organized into four sections. ***Section Two*** provides an overview of the methodology of this study, including a brief introduction of the Urban Nature Atlas, the case selection process, as well as the analytic framework adopted to examine how NBS contribute to biodiversity goals. ***Section Three*** presents and discusses the key findings of the analysis of how urban NBS are contributing to the conservation and restoration of nature, as

well as the city's thriving with nature. ***Section Four*** reflects on these findings to draw out the key lessons about the ways in which cities in Europe were working with nature for biodiversity, and the challenges and potentials for supporting and improving the roles of city in the post-2020 biodiversity agenda.

2 Methodology

Our analysis was based on a sample of 199 NBS projects identified from the Urban Nature Atlas[1] (referred to as the Atlas hereafter), which was established by the NATURVATION project between January and September 2017. This analysis is based on the first results of the Atlas analysis of in total 976 NBS projects (an updated database now includes 1000 cases), which was based on secondary sources (e.g. project reports and other project documents, websites, news articles, research articles, studies and blog posts). Data was interrogated using discourse analysis, and all answers reported in the Atlas are based, without exception, on factual information with a reference. Each NBS project included in the Atlas records information on its project goals and objectives, key characteristics based on its urban settings, ecosystem services provided, governance arrangements (including leading actors), and their direct beneficiaries and impacts, among others. The Atlas thus provides a basis to identify NBS projects that have biodiversity goals and explicit biodiversity actions, which enables the further in-depth analysis of the biodiversity contribution of urban NBS in European cities as presented below.

2.1 Case selection

To select a sample of NBS projects in which there were explicit intentions and measures to contribute to biodiversity – whether that be to *conserve*, *restore* or *thrive* with nature - and which represented the varied urban settings and the diverse leading actor groups (e.g. government or non-government actors) of NBS across European cities, a systematic approach was applied. First, to identify NBS projects that are explicitly intended to deliver biodiversity goals and actions, we conducted a content analysis of the 976 NBS projects included in the

[1] The Urban Nature Atlas provided the first systematic survey of up to 1000 NBS projects from 100 European cities, including 94 cities selected to be representative of European urban conditions from the Urban Audit1 and NATURVATION's 6 partner cities (Barcelona. Győr, Leipzig, Newcastle, Malmö, and Utrecht). The Atlas involved surveying up to 10 NBS projects in each of these 100 cities. The methodology and main findings of the first analysis of Urban Nature Atlas can be found in Almassy et al. (2018). For more information about the Urban Nature Atlas see https://naturvation.eu/atlas.

Atlas. NBS that had one of the words related to specific biodiversity goals or targets – "biodiversity", "species", "habitats" or "biological diversity" – in their "Goals of the Intervention" and "implementation activities" recorded in the Atlas were selected, which resulted in 351 NBS projects. Subsequently, a further analysis of the urban setting of these 351 NBS were conducted. Figure 1 below shows the frequencies of NBS projects in different urban settings.

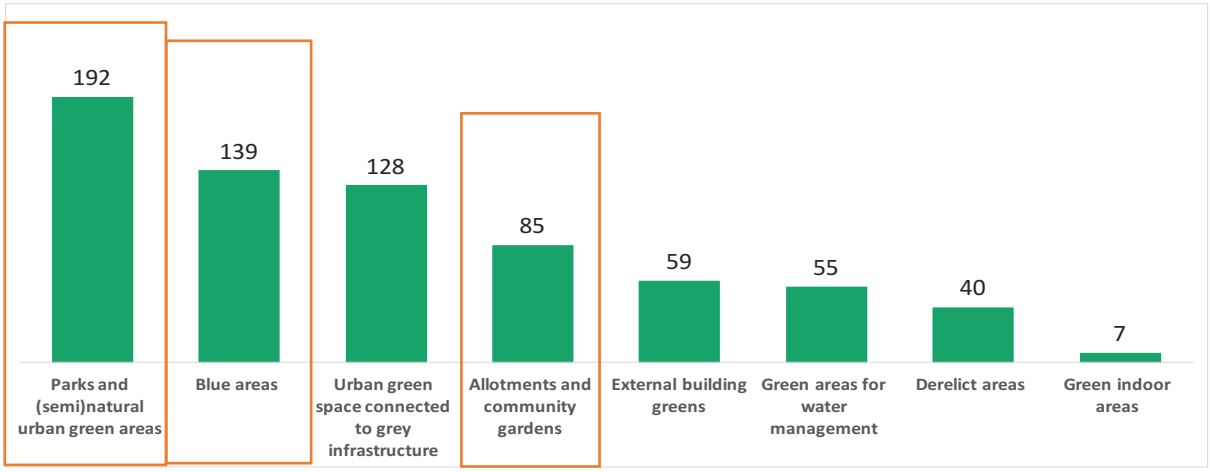

Figure 1: Urban setting of the 351 NBS with explicit claims for biodiversity per urban settings.

From these groups of NBS projects, we selected three types of NBS for further analysis. These include 107 NBS projects involved large urban parks and forests under the category of "parks and (semi)natural urban green areas", 64 NBS involved rivers, streams, and estuaries of the "blue area", and 65 projects involved community gardens of the "Allotments and community gardens"(detailed figures can be found in Figure 2). As two projects related to community gardens were found to have no explicit biodiversity contributions in the following detailed discourse analysis (explained fully below), they were excluded from the study and leaving 63 projects involved community gardens. It is to be noted that one NBS project could be associated with more than one urban settings (for instance, there were 20 NBS projects involved both large urban parks and rivers, streams, and estuaries, 11 projects involved both large urban parks and community gardens, 6 projects involved both urban rivers and community gardens, and 2 projects related to all three urban settings). Therefore, there were in total 199 NBS projects analysed in this study. These projects spread across 82 European cities (see Figure 3). In terms of their stage of the intervention (as of June-August/2017), 12 were in planning stage, 1 was piloting, 93 were ongoing, and 93 were completed.

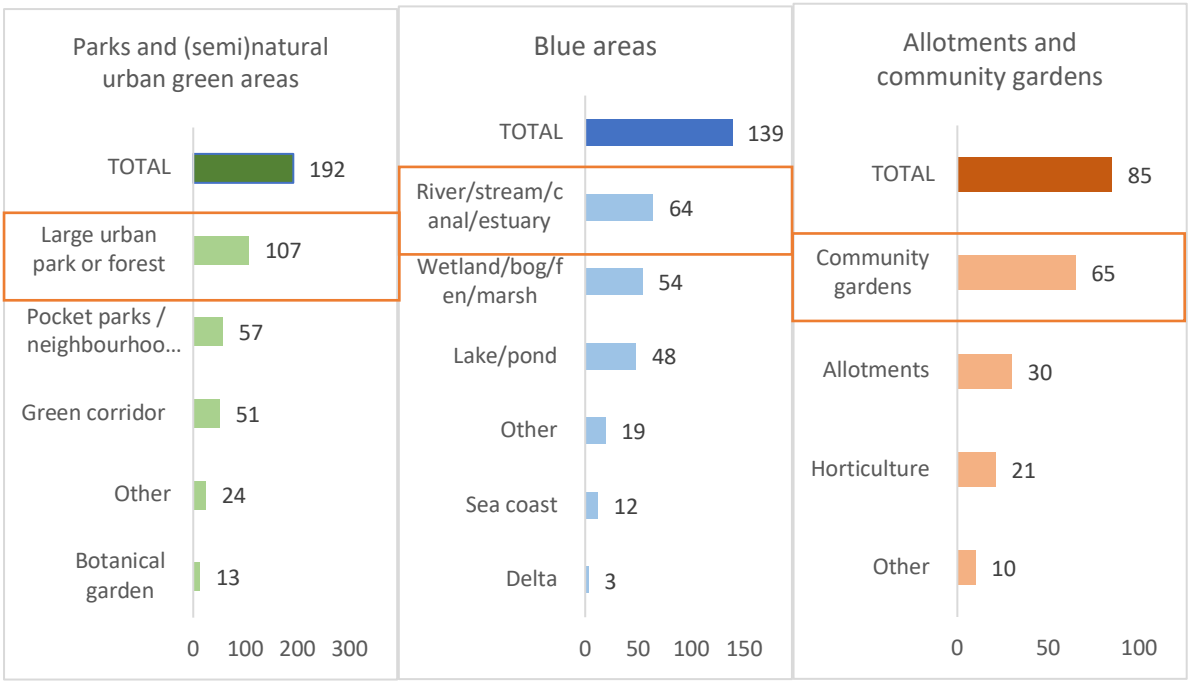

Figure 2: Frequency of NBS in different urban settings

Figure 3: Cities where investigated nature-based solutions were located.

The reasons for selecting cases from three different urban settings is twofold. First, we sought to include NBS located in different urban settings, which involve urban green areas, blue areas and community gardens, in order to capture diverse ecosystems and urban sustainability challenges that might be at stake. Second, we sought to include cases that would represent a variety of key actors: the majority of NBS involving large urban parks (about 82%) and forests and river/stream/estuaries (about 95%) are government-led or involve some forms of hybrid governance, with merely 18% and 5% projects respectively led by non-governmental actors; whilst for the 63 NBS in community gardens, there are 27 projects are led by non-governmental actors, accounting for 42% of the total number. The diversity of urban NBS projects (in terms of their urban settings and leading actors) studied in this research allows us to develop a relatively comprehensive understanding of how a range of actors in different urban settings are seeking to govern biodiversity through NBS in cities across Europe.

2.2 Analytic framework

For the set of 199 cases selected, we conducted an in-depth analysis in terms of their declared biodiversity goals and explicit implementation actions. For each case, we sought to identify whether goals and actions were intended to conserve, restore or to thrive with nature through undertaking a discourse analysis of the project profiling recorded in the Atlas.

The novel approach adopted in this analysis to explore cities' contribution to biodiversity through NBS is to emphasize the ways in which cities can *conserve* nature, *restore* nature and mobilize people's ability to *thrive* with nature. Conservation and restoration are fundamental elements to the Convention on Biological Diversity and are frequently addressed in existing biodiversity research. As defined by International Union for Conservation of Nature and Natural Resources (IUCN), conservation refers to "the protection, care, management and maintenance of ecosystems, habitats, wildlife species and populations, within or outside of their natural environments, in order to safeguard the natural conditions for their long-term permanence." The main goal of conservation is thus to prevent further degradation of natural ecosystem and resources (Young, 2000), although in practice the measures undertaken to achieve such a goal vary and can include the preservation, maintenance, sustainable use and enhancement of the components of biological diversity. While conservation mainly focuses

on preventing ongoing degradation, restoration seeks to actively reverse such degradation (Garson, 2016). As defined by the Society for Ecological Restoration (SER), ecological restoration is "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." With cities' roles in biodiversity conservation being increasingly recognised, more attention is also being directed towards the restoration of urban green spaces for biodiversity habitat (Butt et al., 2018). Restoration activities have often focused on habitat improvement and planting; creating artificial structures for nesting, shelter or to facilitate faunal movement and connectivity between sites; control of pest or invasive species; and community engagement and education programs including citizen science and site or species monitoring programs (Threlfall et al., 2019).

More recently, as the Zero Draft of the Post-2020 Global Biodiversity Framework published in January 2020 makes clear, in addition to seeking to conserve and restore nature a central goal for biodiversity governance in the coming decade is to ensure that nature's contribution to people is also preserved and enhanced (CBD, 2020). Biodiversity is known to provide a series of benefits to people, including biological resource, ecosystem services, and social and spiritual benefits (Kearns, 2010). Yet the global loss of nature is threatening to reduce the potential for nature to contribute towards society in these ways. Therefore, it is of vital significance for biodiversity governance to identify a holistic development and conservation mechanism through which the needs of both human and (non-human) nature can be reconciled. In other words, there is a growing imperative to enable nature and society to *thrive* together. Our analytical framework therefore sought to build on the traditional focus of biodiversity governance – conservation and restoration – whilst also taking account of this new imperative, which in this study we call thriving with nature. By deliberately casting the potential role of urban NBS in these terms, we sought to ensure that the diverse ways in which urban action might contribute to global biodiversity goals could be captured.

Having determined the basis for our analytical approach, we collected data entered under the NBS's "goals of the intervention" and "implementation activities" documented in the Urban Nature Atlas for analysis. In cases where this data was insufficient, other data recorded in the Urban Nature Atlas database, such as the "quantitative targets" and "indicators and specification of impacts", were further examined to acquire sufficient information for the analysis. This process also allowed the validation of the case selection results as two of the 65

NBS projects involved community gardens were found with no explicit claimed biodiversity goals and were thus not processed for further analysis. In terms of conservation and restoration, each NBS was analysed for the type of its biodiversity goals (i.e. genetic-based, species-based, and/or ecosystem-based) and the specific actions undertaken to achieve such goals. In so doing, our analysis draws on the three interconnected levels of biodiversity accepted by international conservation policy since the Rio Conference in 1992, namely the diversity of ecosystems; that of the species or the living organisms making up the ecosystem; and the genetic diversity within each species (UNEP, 1992). In terms of "thriving", we draw on the IPBES Global Assessment report together with the literature on the diverse and multi-functional benefits of NBS (e.g. da Rocha et al. 2017; Díaz et al., 2015; Kabisch et al., 2016; Terton, 2017) to identify nature's contribution to people along five dimensions: 1) cultural benefits; 2) social benefits; 3) economic benefits; 4) benefits for addressing climate challenges; and 5) benefits for environmental quality. This categorisation was done iteratively, such that as data was accumulated, new actions that had not previously been captured were added and analysis re-done for other cases in the sample. Table 1 provides a breakdown of the typology used to analyse the cases.

Table 1. Goals and implementation actions of NBS for conserving, restoring, and thriving with nature

CATEGORY	TYPES OF GOALS	IMPLEMENTATION ACTIONS/DETAILED CONTRIBUTION
Conservation	Genetic-based; Species-based; Ecosystem-based	Preserve and strengthen the existing habitats and ecosystems in the city and its hinterland
		Promote environmentally sound development in areas adjacent to protected/valued areas
		Create new habitats
		Preserve and strengthen habitat connectivity
		Reduce negative impacts and avoid the alteration and damage of ecosystem (e.g. the usage of pesticides, the release of genetically modified organisms, and harmful infrastructure expansion)
		Undertake specific measures to protect species (unspecified)
		Undertake specific measures to protect native species
		Undertake specific measures to protect endangered species
		Undertake specific measures to protect valued species

		Control and clean invasive alien species
		Take measures for ex situ conservation (e.g. establishment and maintenance of gene and seed bank, zoos, museums, breeding centre, and botanical garden/arboretums)
		Biodiversity offsets
		Manage and protect biological resources for conservation and sustainable use
		Raise public awareness
		Public engagement
		Create and use scientific knowledge for conservation
		Capacity building
		Protect and apply traditional knowledge and conservation practices
Restoration	Genetic-based; Species-based; Ecosystem-based	Rehabilitate and restore damaged or destroyed ecosystems
		Restore species (unspecified)
		Restore native species
		Restore endangered species
		Restore valued species
		Clear and control invasive alien species
		Restore ecological connectivity
		Public engagement
Thriving	Social contribution	Education and scientific research
		Health
		Well-being
		Social justice and equity
		Social cohesion and integration
		Safety (including reducing risk of crime and creating a physically safe urban environment)
		Liveability
	Cultural contribution	Recreation, exercise, sports and events
		Cultural heritage
		Aesthetic
		Artistic value
		Spiritual or religious value
		Sense of ownership and identity
		Connecting to nature

	Economic contribution	Employment
		Tourism
		Urban regeneration and development (e.g. create new residences, office spaces, or commercial areas, and increase property value in the area)
		Reduce financial cost for urban management
		Economic production (for profit or not)
		Attract business and investment
	Climate contribution	Carbon sequestration and emission reduction
		Flood prevention and regulation
		Drought (desertification) prevention
		Heat island effects reduction
		Micro-climate improvement
	Environmental contribution	Water regulation and quality
		Noise control
		Air quality control and improvement
		Pollution abatement
		Soil protection and amelioration

3 Results and Discussion

In this section we present our key findings about how cities are working with NBS to conserve and restore nature, as well as to thrive through working with nature. The statistical results of the analysis of 199 urban NBS that involved three urban settings in terms of their different type of conservation and restoration goals (i.e., genetic-based, species-based, or ecosystem-based), explicit implementation actions for achieving such goals, as well as the different types of contributions they made for city's thriving with nature will be presented and discussed.

It is to be noted that the majority of NBS projects have multiple goals for conservation, restoration and for thriving. For example, urban river projects that involved restoring biodiversity often also contribute to flood prevention, water regulation and quality control, as well as the support of recreational activities (e.g. the KingLambro: city regeneration project in Milan, Italy,[2] and the River Alt & Croxteth Brook Restoration Project in Liverpool, the UK[3]),

[2] See: https://naturvation.eu/nbs/milano/kinglambro-city-regeneration-project.
[3] See: https://naturvation.eu/nbs/liverpool/river-alt-and-croxteth-brook-restoration-project.

and urban community garden projects that protect local biodiversity also often deliver multiple social and economic benefits (e.g. the Life Gardens in Zaragoza, Spain[4]).

In general terms our analysis reveals that those NBS with an explicit intention to address biodiversity are currently focused primarily on *conserving* and *thriving* with nature: 174 out of 199 projects had conservation goals and nearly 91 percent of nature-based solutions (181 out of 199) incorporate aspects of thriving with nature. This is especially evident in NBS projects involving large urban parks and community gardens, whilst cases related to rivers, streams, and estuaries show a relatively even distribution of NBS project in three categories (Figure 4).

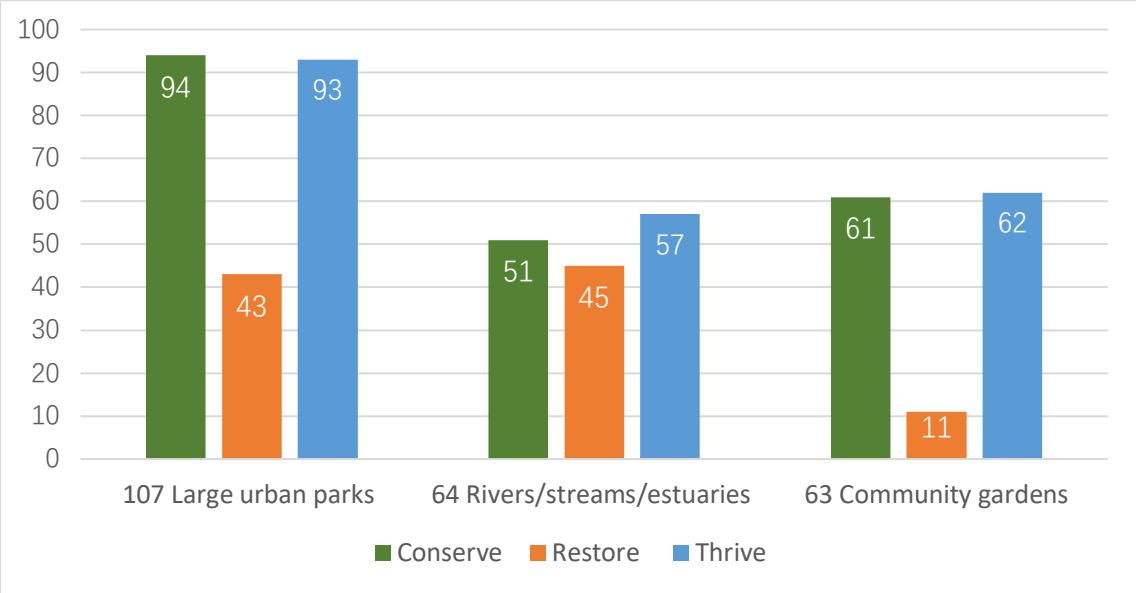

Figure 4: Biodiversity goals and actions of NBS projects in different urban settings and their frequency

3.1 Urban NBS for Biodiversity *Conservation* and *Restoration*

Our analysis shows that current NBS projects that concern biodiversity conservation and restoration placed emphasis on ecosystem diversity rather than species or genetic diversity: for instance, among NBS projects involved large urban parks, 76 out of 94 that with *conservation* goals and 41 out of 43 *restoration* projects, are ecosystem-based interventions (see Figure 5 for detail results). It is to be noted though as the three levels of biodiversity are interconnected, actions at any given level could affect other levels.

[4] See: https://naturvation.eu/nbs/zaragoza/life-gardens.

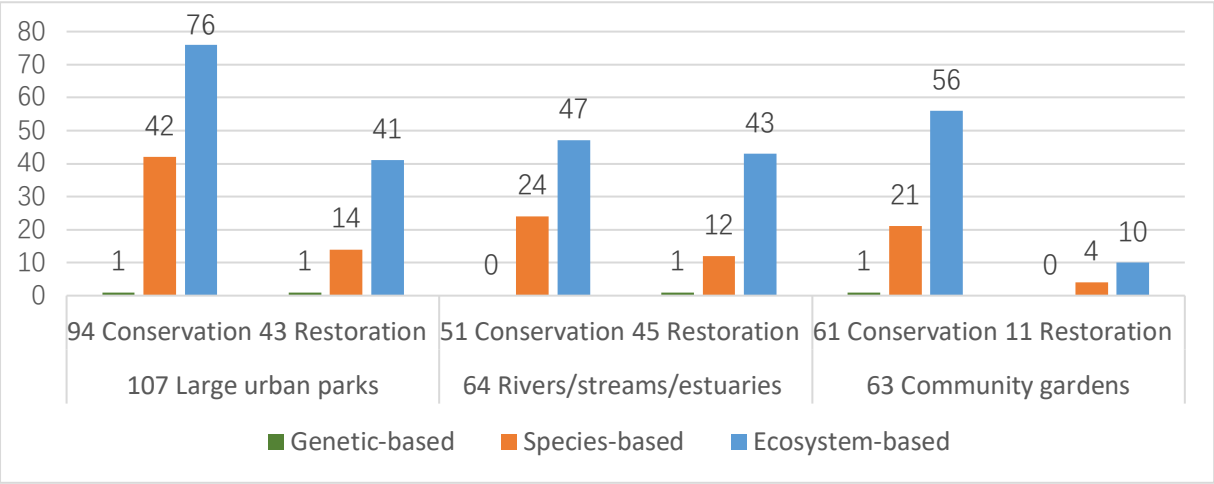

Figure 5: Types of conservation and restoration goals of the NBS projects and their frequency

Ecosystem-based NBS often involved conservation, restoration or enhancement of the integrity, functionality, and connectivity of habitats. For example, one goal of the project "Alna Environmental Park" in Oslo (Norway) was to secure biodiversity, habitats and good water quality in the region along the river; in the "Water Storing Green Park" project of Hague (the Netherlands), a main goal was to improve ecological functioning of the area which improves biodiversity and water storage; and in the "Green and Blue Network project" in Montpellier (France), a goal was to ensure biological connections between the different natural spaces.

Meanwhile, a further review of these ecosystem-based NBS projects found that besides the general descriptive goals for habitat protection and enhancement, a significant number of NBS have set quantitative targets for their conservation and restoration efforts. For example, among the 93 ecosystem-based NBS projects that involved large urban parks, 52 projects had explicit quantitative targets. Examples of the quantitative targets identified in the analysis include:

- **Number of trees to be planted,** e.g. "planting 18,000 trees and bushes" (the Krupp Park project in Essen, Germany), "adding 135,000 plants" (Green Park on Highway Tunnel in Utrecht, the Netherlands), and "planting 12,089 trees" (the Spring Cleaning project in Ljubljana, Slovenia).
- **Area of green or blue areas to be created or restored**, e.g. "afforesting 320 ha of new forest within four years" (the Afforestation in the City of Århus, Denmark) and

"constructing a total of 23 ha of the park, 9,100 m² of water surface area, and 4.5ha of a forest area" (the Krupp Park project in Essen, Germany).

- **Number of green areas created in the city**, such as "creating 10 diversified gardens in 33 different plots" (the community garden project in the City of Lille, France).

In comparison, there are fewer NBS projects that concerned species diversity, and these interventions display certain common features in their claimed goals and actions. First, many species-based projects (e.g. 16 out of 50 species-based NBS projects involved large urban parks, either with conservation or restoration goals) also employed quantitative targets in their goals of interventions. For example, the Asomadilla Park in Córdoba (Spain) was designed to stimulate a Mediterranean forest with 18 native species of Mediterranean flora, and the Ecological Infrastructure in Port of Antwerp (Belgium) launched a species protection programme for the conservation of 90 protected species by means of creating ecological infrastructures.

Second, whilst many urban NBS projects do not specify any particular species for conservation and restoration, a number of species-concerned NBS interventions did target one or several specific types of species. A typical example case is the Le Lez River programme launched by the City of Montpellier in France, of which one major aim was to protect the unique fish species that only exist in the river called "Chabot-du-Lez". Other examples include the conservation of Dictamnus albus (e.g. the Biodiversity Conservation project in Bologna, Italy); the protection and/or recovery of water vole (e.g. the River Restoration on the Guphill Brook in Coventry and the Water Vole Recovery Project in Reading, the UK); lizard (e.g. the City development project in Central Railway Area of Munich, Germany); and Willow Tit (Inspiring Water Action in Torne – Doncaster, UK). These species were either endangered or rare, and endemic in the region that were vital for the ecosystem.

We found that there were very few NBS projects involved specific genetic diversity goals and actions (Figure 5). Only three out of all NBS had specific goals for genetic diversity. One project – the Mountain Forest Initiative in Augsburg, Germany – covered both urban parks and rivers, with intention to improve the age and species distribution of individual stocks. The other two were 1) the O'pflanzt community garden in Munich, Germany, whose intervention goals include "promoting genetically diverse regionally grown seasonal crops"; and 2) the Glasgow Green Park in the UK that aimed to "introduce and preserve the already present species and

maintain high genetic diversity".[5] It is argued by Coates et al (2018) that current approaches to biodiversity conservation are paying little attention on genetic diversity and the species-population continuum. This is substantiated in this analysis of NBS across European cities. Genetic diversity was largely ignored, and while further case-based research is needed to understand the reasons for this it may be that cities do not (yet) see themselves as key actors in relation to genetic diversity or already seek to address this in accordance with species richness through their actions at an ecosystem scale.

In keeping with the focus on ecosystem level conservation as a goal, our analysis of the main conservation actions undertaken by NBS found that in all three urban settings, two conservation measures that work at the ecosystem level were the most popular: 1) preserve and strengthen the existing habitats and ecosystems, and 2) create new habitats. For example, among the 94 NBS involved large urban parks that had conservation as their goals, 47 involved preserving and strengthening habitats and 42 contributed to create new habitat.[6] Other conservation measures that were often used include: preserving and strengthening ecological connectivity, undertaking specific measures to protect valued species, and raising public awareness.

Although the importance of preserving and applying indigenous knowledge in biodiversity conservation has long been acknowledged (Gadgil et al., 1993; Harrison and Davis, 2002), it was undervalued in current urban NBS practices. Only seven projects (two in large urban parks and five in rivers) were found to involve the protection and application of traditional knowledge in their conservation practices. For example, the project *of Preserving Biodiversity in Conservatoire des Restanques in Marseille* (France) highlighted the knowledge of former Provençal farmers with the culture on the "bancaous" (restanques in Provençal)", which referred to two-facing retaining walls built in dry-stone landscape to create terraces for planting. Also, in the construction of community gardens of City Park in Barcelona (Spain), the lead actor – the Association of Friends of the Botanical Garden – focused on the cultivation of traditional horticultural breeds, so as to develop a vegetable garden of traditional varieties

[5] Land & Environmental Services Glasgow Green Management Plan 2016-2019. URL: https://www.glasgow.gov.uk/CHttpHandler.ashx?id=31510&p=0. Accessed on 27th June 2017.

[6] Detailed figures of all NBS in different urban settings regarding their frequencies of conservation action can be found in Figure 1, 2, and 3 in the Supplementary Materials available online. When reviewing the result, it is to be noted that one project could take more than one conservation measure.

in the space of the Masía del Jardí Històric. Other measures that were seldom used, or not used, include: Capacity building; Ex situ (off-site) conservation, and Biodiversity offsets.

Compared to conservation, restoring biodiversity has received much less, and varied, attention in urban settings (Figure 4). First, nearly all NBS with restoration goals and efforts involved rehabilitating and restoring degraded ecosystems. This includes 40 out of 43 NBS projects in large urban parks, 43 out of 45 in urban rivers, and 10 out of 11 in community gardens.[7] Among urban nature projects in rivers, streams, and estuaries, rehabilitation and restoration of degraded ecosystems often involved re-naturalization of a water course or riverbed and/or restoration of ecological connectivity. For example, the Grémillon Stream Flooding Control Planning project in Nancy (France) planned to decrease water flows and remove artificial banks to create a natural stream for ecological gain. These results echo the key messages of the IUCN's report – *River Restoration and Biodiversity: Nature-Based Solutions for Restoring the Rivers of the UK and Republic of Ireland* – that "river restoration is important for achieving biodiversity conservation and sustainable development", and that "working with nature allows us to achieve many otherwise conflicting objectives" (Addy et al., 2016). Other restoration measures used: Restoring valued, native, and endangered species; Clearing and controlling invasive alien species; Restoring ecological connectivity; and promoting public engagement. However, these measures have not yet been widely employed by the projects.

3.2 Urban NBS for city's *thriving* with nature

In terms of thriving, NBS projects located in different urban settings brought various contributions to urban society: projects focused on large urban parks and forests, and on rivers, streams, and estuaries, mainly provided cultural benefits (79% and 65% respectively), whilst Projects focused on community gardens mainly provided social benefits (84%).[8] The various types of contribution made by NBS in different urban settings as well as the detailed dimensions of such contribution being made and their frequency are presented and discussed below.

[7] Detailed figures of all NBS in different urban settings regarding their frequencies of restoration action can be found in Figure 4 in the Supplementary Materials available online.

[8] Detailed figures of all NBS in different urban settings regarding their wider benefits can be found in Figure 5 to 10 in the Supplementary Materials available online.

Previous research has shown that in regard to the associated cultural contributions of NBS, recreational benefits were most prevalent (da Rocha, Almassy, and Pinter, 2017). Similar results were shown in this analysis as among the seven categories of cultural benefits we found that the provision and support of recreation, sports, and various events was the most mentioned: 53 NBS in urban parks (57%), 29 involved urban rivers (51%), and 22 in community gardens (35%). However, whilst aesthetic and spiritual benefits were found to be the second and the third most discussed cultural contributions of NBS in scientific literatures (da Rocha, Almassy, and Pinter, 2017), their existence in NBS with specific biodiversity goals across European cities was not evident, especially there was no NBS found that was linked to spiritual and religious aspects. This could suggest that where biodiversity goals are to the forefront, there has been a missed opportunity to also considered the wider cultural benefits of nature, in keeping with the history of urban conservation efforts as predominantly science-led.

In contrast, whilst literature reviews found that the cultural impacts of NBS related to safeguarding cultural and historical heritage were the least mentioned, this analysis showed that in practice, it has been recognized and embraced by many NBS projects across European cities: there were 23 NBS related to large urban parks concerned cultural and historical heritage, and 13 and 8 in NBS involved urban rivers and community respectively. Actions undertaken by urban NBS to safeguard cultural and historical heritage mainly involve: 1) preserving and protecting cultural heritage sites (e.g. the New Traditional Meadow Orchards in Wuppertal, Germany and the Morningside Park in Edinburgh, the UK); 2) restoring environmental and cultural heritage (e.g. the Green Ring in Antwerp, Belgium, and the Renovation of the Serralves Park in Porto, Portugal); and 3) improving heritage sites for active use (e.g. the Great Lines Heritage Park in Medway, the UK and the Alna Environment Park in Oslo, Norway).

Same research conducted by da Rocha, Almassy, and Pinter (2017) also shows that with regard to the social contributions made by NBS, enhancing well-being (including people's mental health and physical health) and providing opportunities for social interaction (e.g. through improving the sense of community and providing meeting space for residents) were the most discussed in scientific literature, which were followed by the provision of opportunities for various social interaction. However, statistical assessment of the findings from analysis of our sample showed a different result. Firstly, among the seven dimensions of social contributions of urban NBS identified from our analysis, educational development

and scientific research support was the most mentioned in NBS located in all three urban settings. This was often achieved through the provision of educational sites situated in nature (e.g. the CITE educational and community garden in Liège, Belgium), the cooperation with education organizations (e.g. the Forest botanical garden "Marszewo" project in Gdynia, Poland), the establishment of an education institution (e.g. the permaculture farm in community garden project in Wuppertal, Germany and the Mill Leat Restoration in Bute Park, Cardiff, the UK), and the establishment of educational programs (e.g. Community garden: old crop vegetable garden). This again points to the ways in which biodiversity focused NBS may continue to privilege a science-based approach to the benefits of nature, and have not yet pursued the multiple other forms of social benefit that could arise in relation to biodiversity interventions.

Meanwhile, we also found some variation in the type of social contributions made by NBS taken place in different urban settings. Whilst promoting social cohesion and integration was not mentioned in any NBS involved urban rivers and it was incorporated in the goals and actions of only six NBS projects taken place in urban parks, it was the second most commonly identified social contribution of NBS involved community gardens (in total 30 out of the 62 NBS projects that involved contributing to thriving). Example cases include: 1) The Allotment Gardens in Oslo (Norway), which emphasized the allotment management's contribution to biodiversity and social cohesion in terms of the sense of belong in the allotment community;[9] and 2) the "Beds and bees, urban food for humans and bees" project in Karlsruhe (Germany) that combined plants and flower plots with beehives to create new space for humans and animals through the participation of local residents, which created a feeling of belonging in the district.[10]

Meanwhile, our analysis also found that NBS that have biodiversity goals can contribute to urban economy in various ways. For those projects that involved large urban parks and urban rivers, their economic contributions were mostly related to the promotion and enhancement of urban regeneration and development, local tourism, and economic production such as agriculture. For NBS involved community gardens, the main economic benefit delivered was through the promotion and reinforcement of economic production (either for profit or non-profit). For example, in Glasgow in the UK, a project has been implemented to turn derelict

[9] See https://naturvation.eu/nbs/oslo/allotment-gardens-oslo.
[10] See https://naturvation.eu/nbs/karlsruhe/beds-and-bees-urban-food-humans-and-bees.

area into a community garden. The goals of this intervention include habitat creation for certain species to increase biodiversity and to produce locally growing food;[11] and in the city of Montpellier, residents were allowed to rent plots of garden, which aimed for biodiversity preservation and urban landscape, as well as the production for the own needs of citizens.[12]

Besides, the concept of NBS is also closely associated with the subject of climate change mitigation and adaptation (Potschin et al., 2014). For all three groups of NBS projects, flood prevention and management was the most discussed contribution for urban resilience and adaptation to climate change. Meanwhile, NBS related to community gardens were also found to emphasize the benefits they can provide for mitigating and adapting to the urban heat island effect (e.g. the Ermekeil community gardening project in Southern Bonn, Germany,[13] and the Sea Heroes Community Garden in the Hague, the Netherlands[14]), which support the academic arguments of the climate contributions of urban gardens (Cabral et al., 2017; Tsilini et al., 2015). However, it is noteworthy that although flood control was highlighted in current European NBS projects, the prevention of drought and desertification in urban areas was seldom stressed, with merely one of each NBS located in urban parks and rivers identified with related claims and actions. We thus suggest that future NBS projects should take the impact in drought and desertification prevention and amelioration into account as the same level as flood prevention and regulation, as climate change often causes increased floods in some areas and shortages and droughts in others.

Finally, our analysis also found that urban NBS projects contribute to the protection and improvement of environmental quality, especially through water regulation and quality enhancement. Besides the water benefits, NBS can also promote the air quality in urban area. Whilst the findings showed that there were a few NBS projects contributing to soil protection and amelioration, it was relatively underrated. As the potential of NBS as a cost-effective long-term solution for land degradation (e.g. enhancing the soil health and soil functions) has been revealed (Keesstra et al., 2018), we suggest future NBS interventions consider its associated benefits for soil protection and enhancement.

[11] See https://naturvation.eu/nbs/glasgow/derelict-area-turned-community-garden.
[12] See https://naturvation.eu/nbs/montpellier/family-gardens-montpellier.
[13] See https://www.naturvation.eu/nbs/bonn/ermekeil-community-gardening-project-southern-bonn.
[14] See https://naturvation.eu/nbs/hague/sea-heroes-community-garden

4 Conclusion

There is increasing recognition of the potential and significance of NBS for biodiversity conservation and ecological restoration (Cohen-Shacham et al., 2019). However, the role of such approaches for addressing biodiversity protection through the urban realm has yet to be fully explored. In order to build the evidence base concerning how cities are currently making a positive contribution to biodiversity goals through the NBS projects, and what this might mean for global biodiversity governance, this paper provides an initial analysis of the ways in which European cities are addressing biodiversity concerns through the implementation of NBS. We developed a three-fold analytical framework to capture this contribution as involving efforts focused on conservation, restoration and thriving with nature. Taking our starting point as the 976 cases of NBS included within the Urban Nature Atlas, we found that only little over a third (351) are explicit in including biodiversity goals and actions in their design and implementation. This means that not all nature-based solutions are geared toward a biodiversity agenda. Further efforts to support the design and implementation of NBS so that they can explicitly include biodiversity in their efforts may provide an example of a 'low hanging fruit' through which cities can come to be engaged with the biodiversity agenda.

Through our analysis of 199 cases we find that for those NBS interventions that explicitly include biodiversity, their goals and actions varied. Here, the form that NBS take plays a significant role. NBS that work with nature in urban parks and community gardens focused primarily on conservation and thriving with nature (through mobilising nature's contribution to people), with much less attention given to goals for restoration. In contrast, where NBS involved rivers, streams, and estuaries, restoration had received relatively similar level of emphasis as conservation and thriving. This suggests that as the international community come to focus on a 'decade of restoration' engaging urban actors in sharing their lessons from such projects and seeking to further embed restoration across different urban landscapes could also provide a means through which to further accelerate urban engagement with global biodiversity goals.

Across all types of intervention, we found that their biodiversity goals and explicit implementation actions were primarily ecosystem-based, focusing on the protection,

restoration or enhancement of the integrity, functionality, and connectivity of habitats and ecosystems. In general, there were fewer species-based NBS projects amongst our sample, and very few projects concerned with conserving or restoring genetic diversity. Future urban NBS interventions may be able to enhance their contribution towards global biodiversity goals by including a greater focus on the species and genetic elements of biodiversity conservation and restoration, both in terms of project design and by monitoring the effects of those efforts focused at the ecosystem level in terms of their contributions to protecting key species or creating new opportunities for endangered or locally valued species to be reintegrated into local places. This is likely to require capacity-building at the local level in terms of both building the relevant expertise and in terms of developing appropriate assessment tools.

Further examination of the detailed goals and explicit actions of the projects included in this analysis found that a number of NBS interventions adopted quantitative targets to guide their implementation, such as number of trees to be planted, area of green or blue areas to be created or restored, number of green area to be (re)created, number of species to be protected or reintroduced, and number of jobs to be created. European cities are therefore taking quantified, measurable actions for biodiversity conservation, restoration and for thriving with nature. This may provide the foundation for engaging cities in moving towards global goals, by attending to the kinds of targets and indicators that are seen to be relevant, practical and measurable at the local level. Rather than operating through a system of internationally determined targets, as has been the case over the past decade with the focus being on the Aichi Biodiversity Targets, this may suggest that once the overall goals of the global framework for biodiversity governance have been established a degree of flexibility in terms of how they are interpreted and implemented locally will be required in order to make them meaningful. Furthermore, given the increasing momentum behind initiative-led, experimentation as a mode of governing sustainability in the city, it is likely that targets that only focus on plan development and implementation will not suffice to capture and further improve the kinds of actions through which cities (at least in the European context) are acting on biodiversity goals.

These findings rest on a particular investigation into the biodiversity contribution of current NBS projects implemented across Europe and are therefore subject to several limitations. First, our research is based on the analysis of secondary data and was focused on the declared

intention and the implementation activities published or reported by the NBS examples analysed in this research. As is the case with environmental discourse analysis more broadly, this does not tell us about the on-the-ground implementation of the projects or whether their intentions have been realised. Second, by focusing on the project-based initiatives without explicitly analysing their links to the wider institutional policies and goals we cannot establish whether these NBS initiatives have been undertaken in relation to urban biodiversity action plans. However, given that recent analyses suggest that fewer than 150 such plans have been produced globally and our analysis found no explicit mention of LBSAPs or other elements of the biodiversity planning system (e.g. Aichi Targets) (The Nature Conservancy, 2018), we consider this to provide a novel form of urban biodiversity governance.

Even with these limitations in mind, this study of how cities are working towards biodiversity goals suggests that it is imperative that the contributions that cities can make to conserve, restore, and thrive with nature through NBS are recognized and valued by those seeking to make the case for strengthening the role of local and sub-national action within the post-2020 governance framework. First, recognising the ways in which biodiversity is practically being pursued through such forms of intervention at the local level will be critical if these efforts are to be scaled up and mobilised globally. The mobilisation of cities towards climate change goals globally has relied on the efforts of transnational municipal networks and multilevel governance frameworks that have been able to account for and support a wide range of initiatives and actions within and beyond local climate change plans. Indeed, much of the experimentation taking place in cities towards climate change has been directly financed or rewarded through the global policy framework (e.g. the NAZCA platform). Given that it is in relation to climate change that urban action for sustainability has been most successfully mobilised to date, there are important lessons here for how a similar groundswell of action can be engendered in the biodiversity domain.

Second, without attending to the ways in which biodiversity governance is taking place through urban NBS projects, there is a risk that any new framework for post-2020 biodiversity governance will fail to provide the appropriate levels of ambition, governance arrangements, structures of finance and forms of recognition necessary to support its implementation on the ground. The Zero Draft of the post-2020 governance framework published in January 2020 takes an overly narrow view of the capacity of local governments, focused primarily on their

planning powers and neglecting the other capacities that they can bring to the table. Without a full recognition of how cities can support the post-2020 biodiversity agenda, it is likely that we will continue to witness a missed opportunity for aligning biodiversity action with work that cities are already undertaking with nature reducing the possibility for meeting ambitious global targets and leading to the impoverishment of urban life.

Overall we find that cities are contributing to biodiversity governance through the implementation of NBS, and doing so in ways that encompasses both biodiversity for its own sake as well as in terms of nature's contributions to people, and often adopt goals and targets that are quantifiable and measurable. In a context where such actions are rarely considered as making a meaningful contribution to biodiversity, either directly or because of their benefits in shaping the views and values of the majority of the world's population and economic actors who live and work in cities, there is an emerging need for transnational and international governance arrangements that can acknowledge the contributions of cities that are working for biodiversity and can guide other cities to take actions towards biodiversity in their jurisdictions. We hope that these findings can provide insights that can ensure that the post-2020 biodiversity governance framework is able to provide the basis for furthering urban action towards biodiversity goals, and that such goals can support ambitions for urban sustainability globally.

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Supplementary Materials

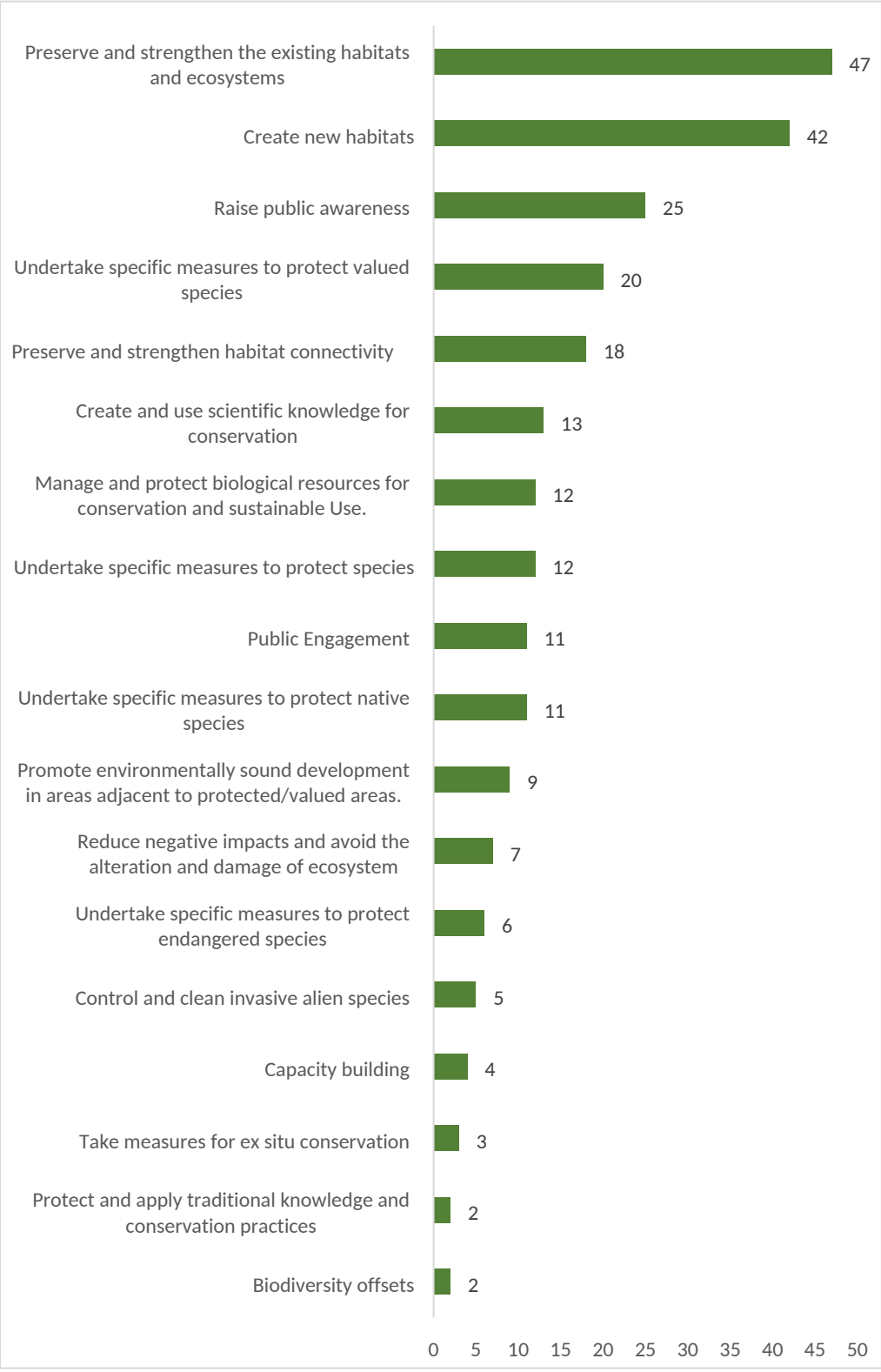

Figure 1: Frequency of conservation measures adopted by nature-based solutions involved large urban parks

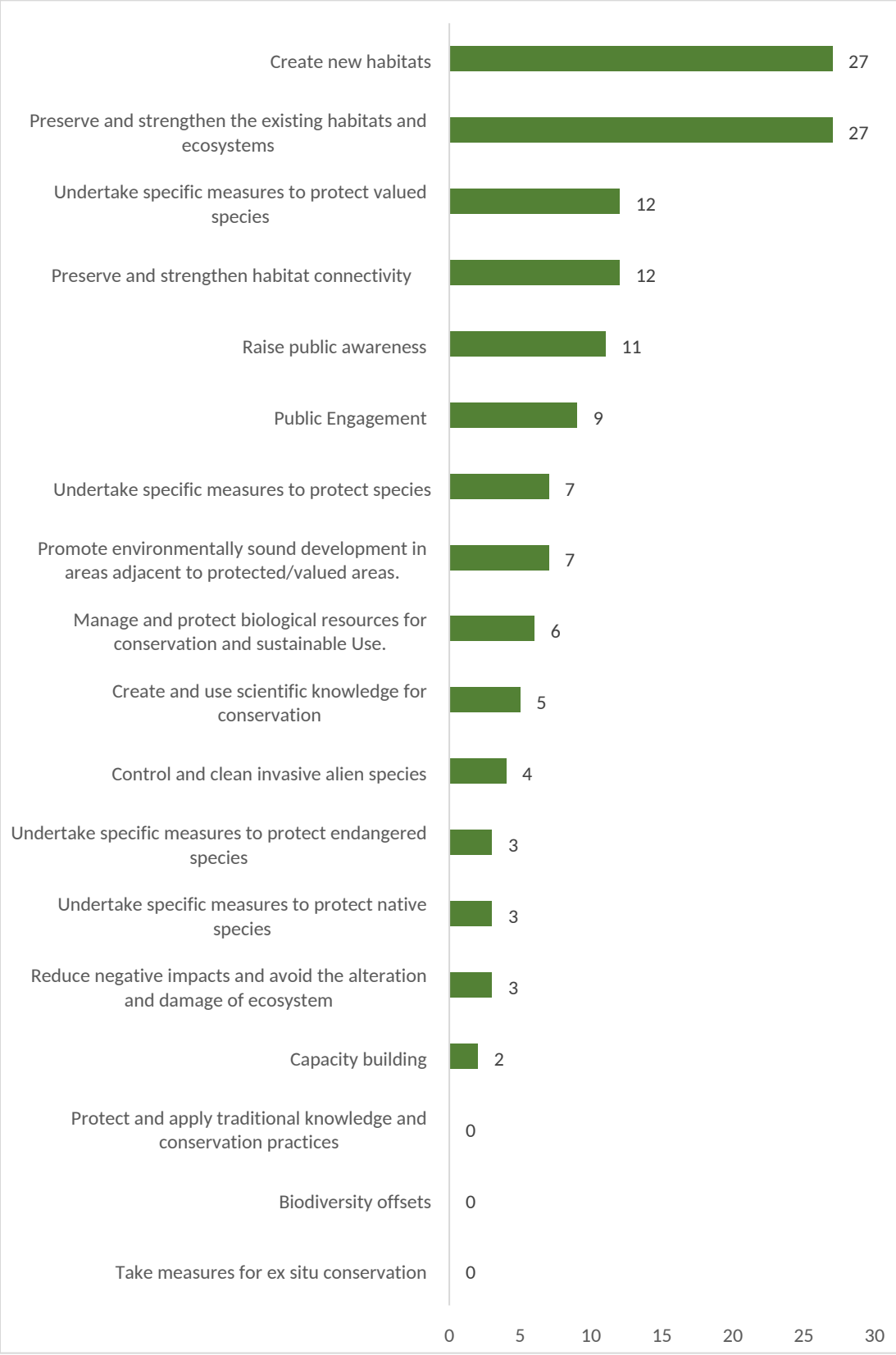

Figure 2: Frequency of conservation measures adopted by nature-based solutions involved urban rivers, streams, and estuaries

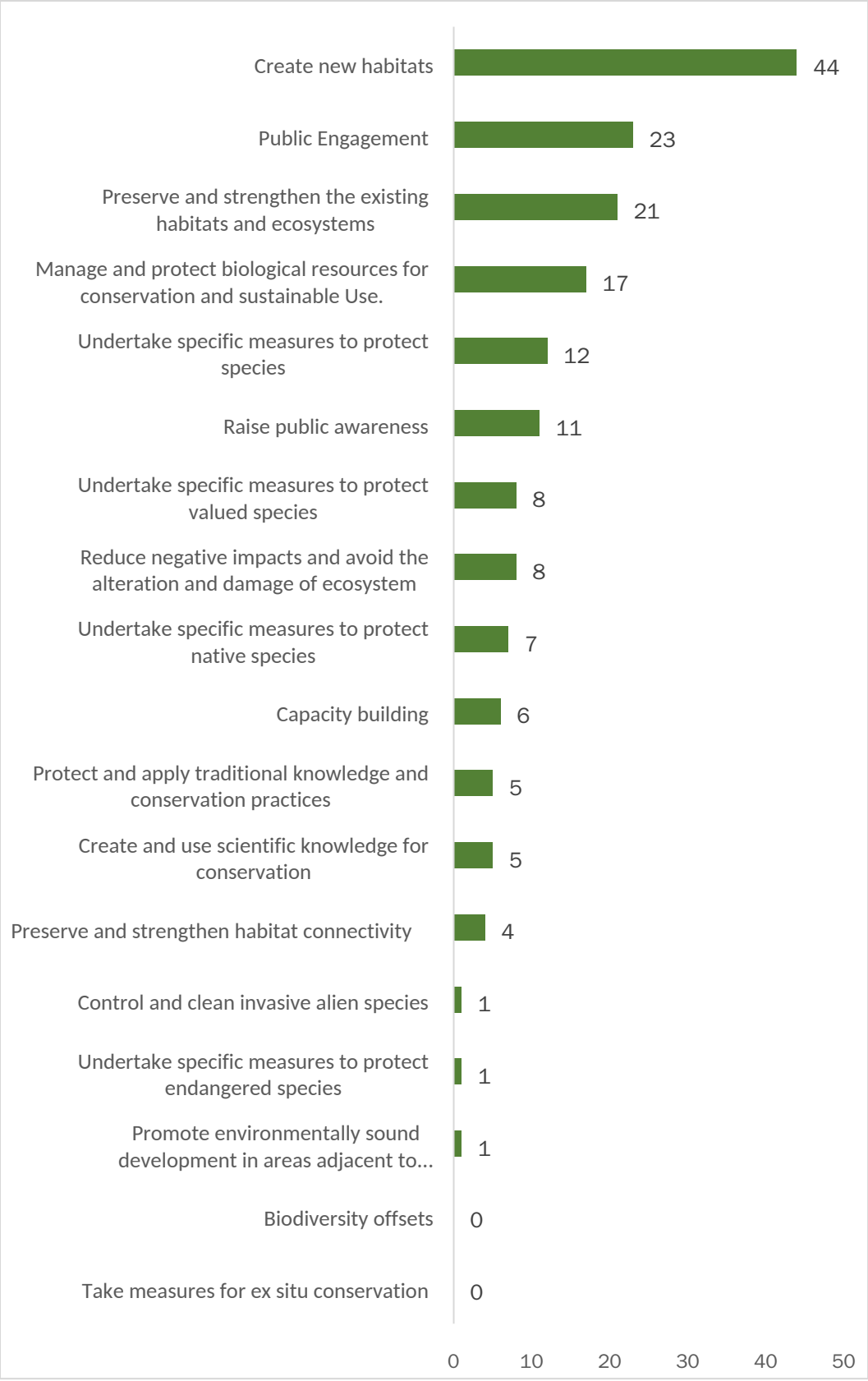

Figure 3: Frequency of conservation measures adopted by nature-based solutions involved community gardens

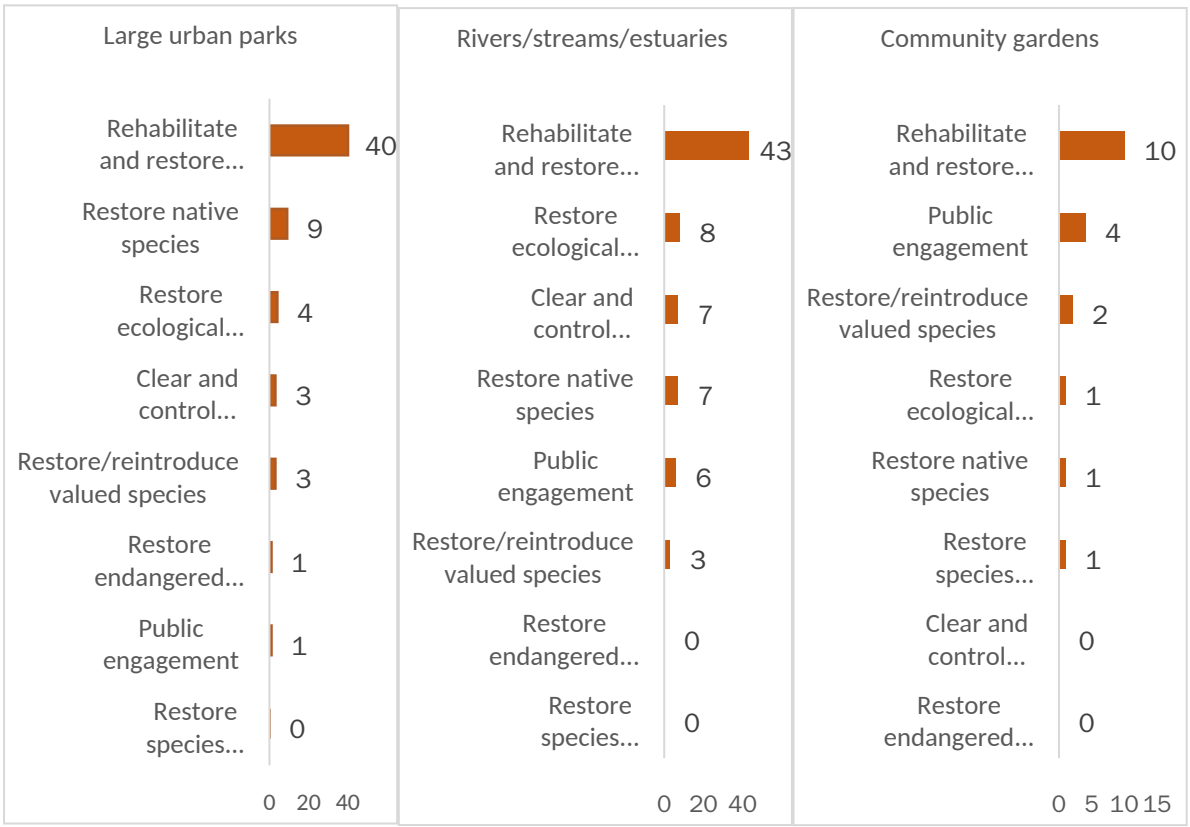

Figure 4. Frequency of restoration measures adopted by nature-based solutions involved community gardens.

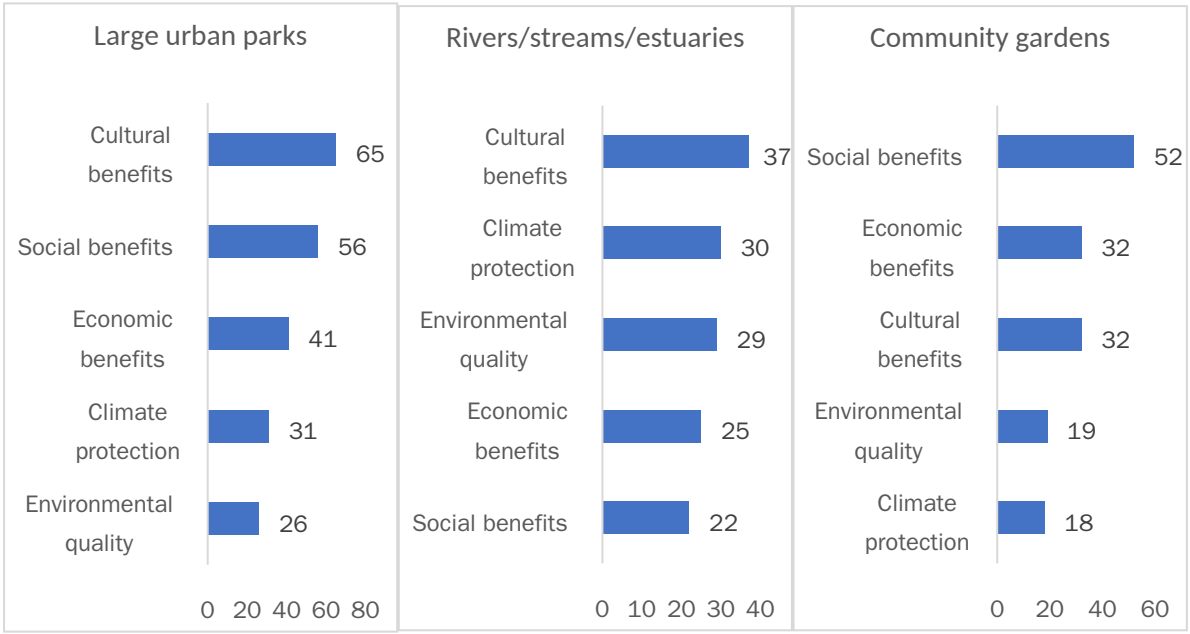

Figure 5. Various contributions provided by nature-based solutions in three different urban settings and their frequency

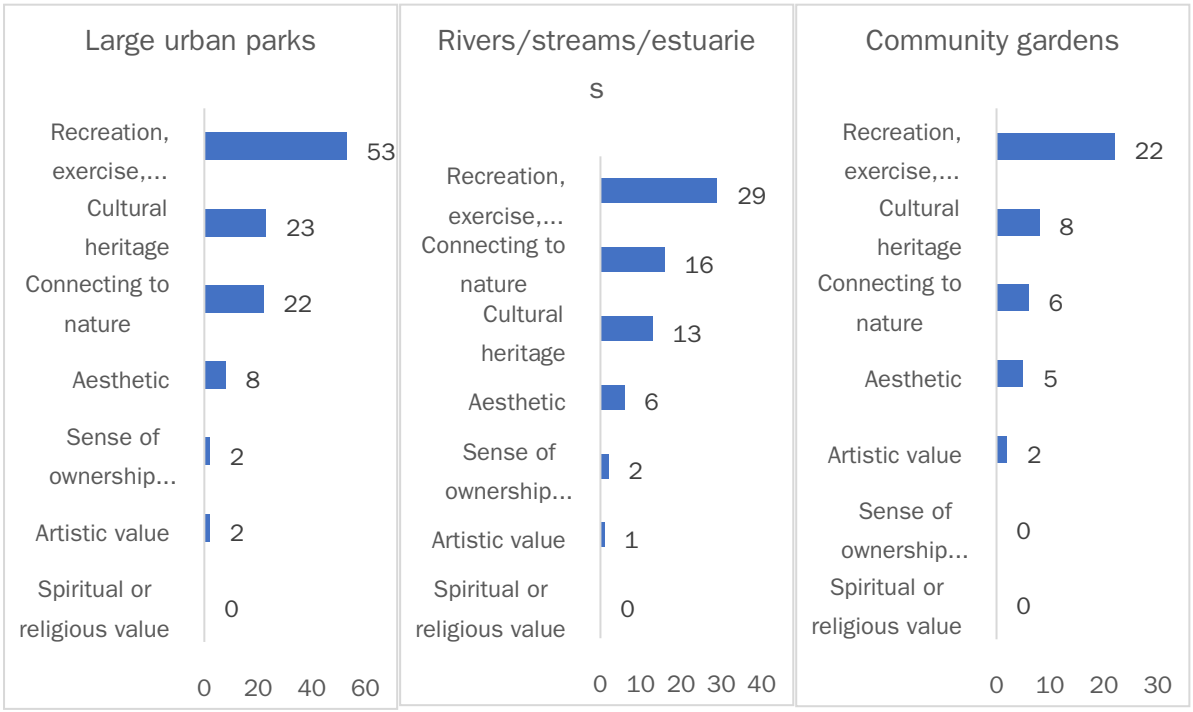

Figure 6. Cultural contributions provided by nature-based solutions in European cities

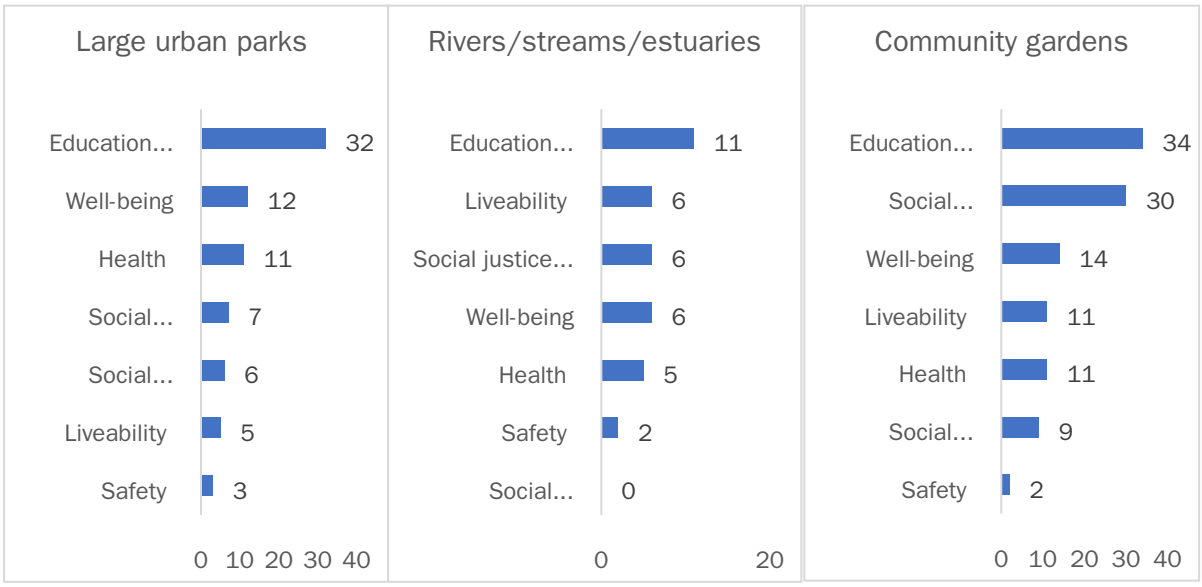

Figure 7. Social contributions provided by nature-based solutions in European Cities

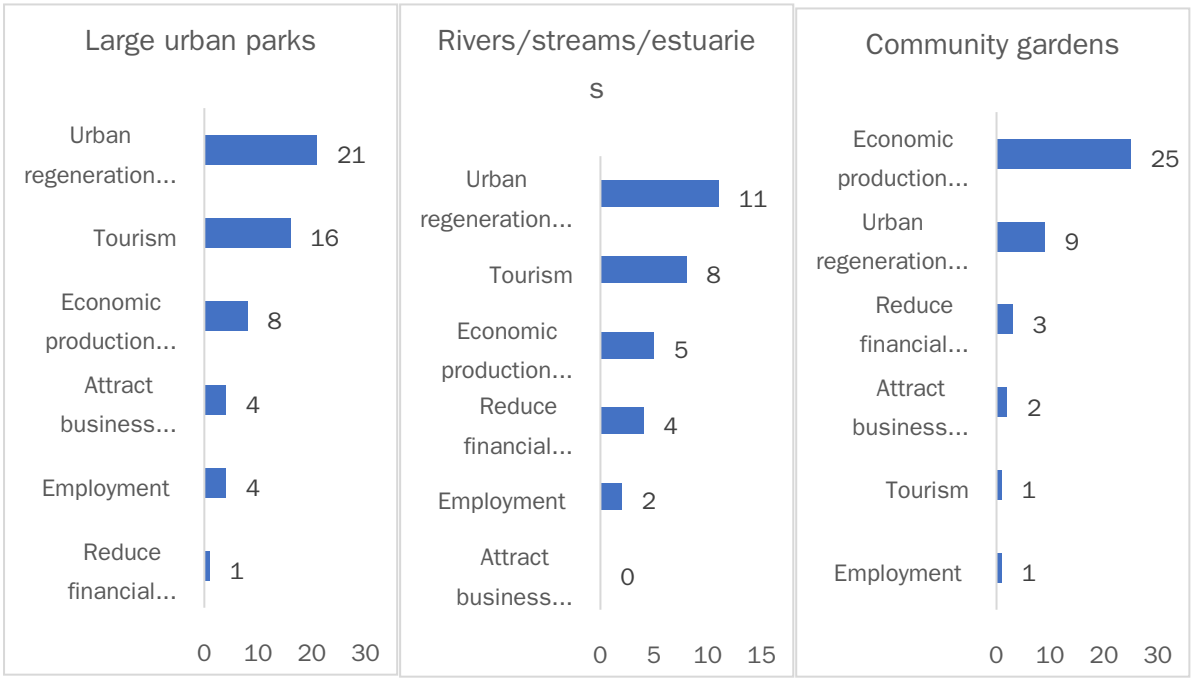

Figure 8. Nature-based solutions' contribution to economy in European cities

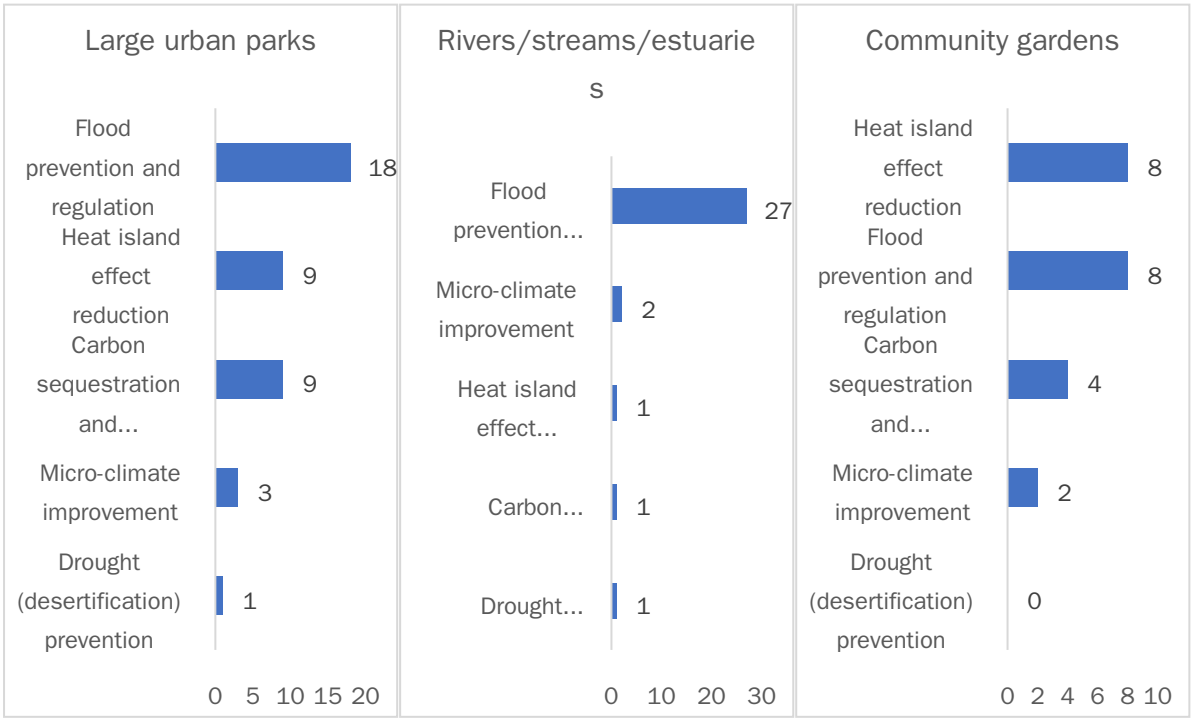

Figure 9. Nature-based solutions' contributions to climate mitigation and adaptation in European cities

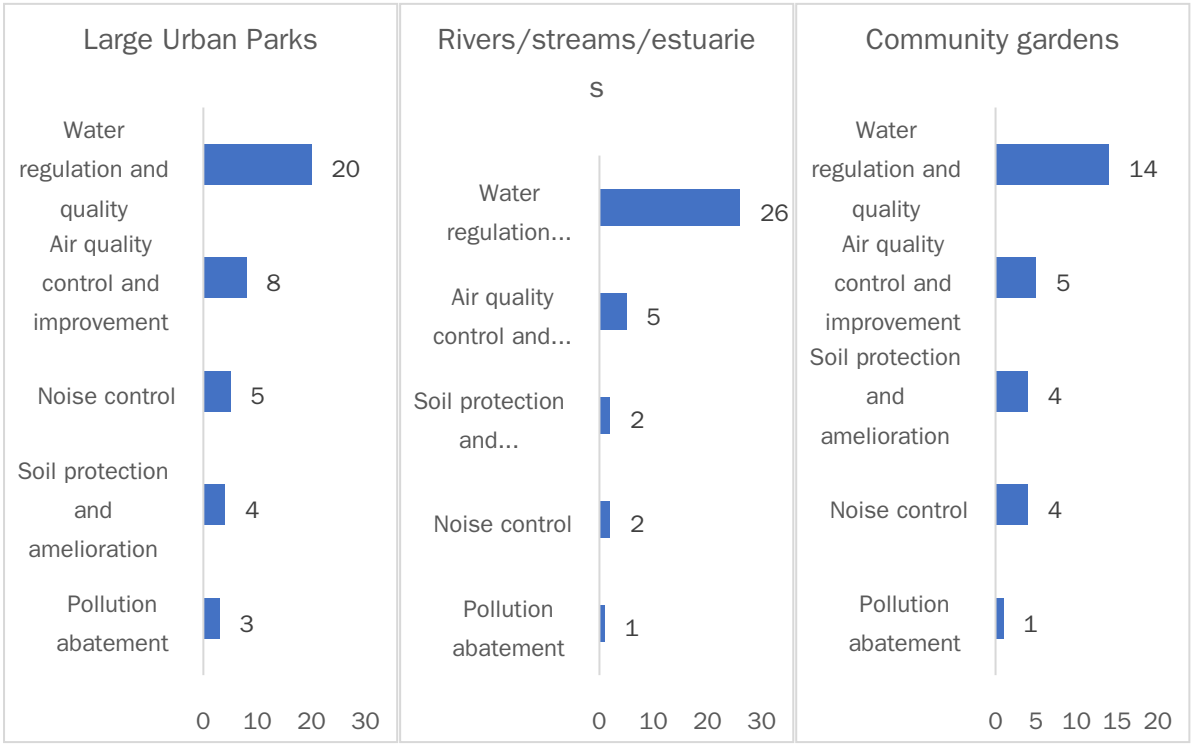

Figure 10. Nature-based solutions' contributions to environmental quality in European cities